

Editorial overview

Nanomaterials — Electrons in mesoporous semiconductor/liquid thin films

Within the past decade a new branch of electronic materials has developed – one which hybridizes ideas and methods from colloid chemistry, electrochemistry and solid state physics. In these nanoscale thin films two very dissimilar phases, a solid semiconductor and a liquid, are intimately mixed and percolate across the film. Charge transfer across the liquid:semiconductor interface is efficient and can generate strong electroluminescent and/or photovoltaic effects in view of the huge internal surface area. Understanding and control of interfacial surface chemistry is absolutely critical.

Nobu Koshida describes the basic properties and mechanisms of porous Si, made by electrochemical etching of crystalline Si wafers, from an electrical engineering perspective. This material is an aerogel-like scaffolding of partially fused Si nanocrystals and/or Si wires of undulating diameter. In material of high porosity, the nanocrystals have 2-4 nm size so that the electrical and optical properties are size due to quantum confinement. These films show strong electroluminescence; the luminescence color depends upon nanocrystal size.

Michael Gratzel describes a new type of solar cell, involving sintered titanium dioxide particles with a redox electrolyte in the pore structure, from a colloid and photochemistry perspective. With a photosensitizing dye chemisorbed at the interface, this material shows more than 10% power conversion efficiency in

solar cell configuration. With electrons moving ('hopping') in the oxide particles, and holes moving in the electrolyte as oxidized molecular species, recombination is remarkably slow. Almost all of the photogenerated charge is collected in the external circuit.

These two reviews illustrate how, as is often the case, new science and the genuine prospect of real application go hand in hand as a novel area slowly reveals its secrets. Both articles are written by pioneers in their respective fields. These areas have developed essentially independently. It is revealing and fascinating to read these reviews side by side, as the two communities struggle with similar problems. Efforts are underway to find a solid phase replacement for the liquid phase for device purposes, and to understand the true nature of electron transport among semiconductor particles in the presence of strong screening by a high ionic strength electrolyte. Koshida describes recent experiments revealing ballistic electron transport across nanocrystal interfaces. Gratzel describes how self organized mesoscopic films might be made by hydrothermal growth. It is an exciting time to be working in nanoscale science.

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